



WBS 2.9.4 Far Detector Block Assembly & Installation

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CD-2 Director's Review of NOvA
June 4-7, 2007



Block Assembly & Installation

- WBS 2.9.4 Labor Costs
- Hiring Plan
- Setup Period
- Startup Period
- WBS 2.9.4 Breakdown
- Block Assembly and Schedule
- ES&H and Training
- Summary



WBS 2.9.4 Labor Costs

- Labor costs are combined for all WBS 2.9.4 tasks in NOvA_BoE_2.9.4_labor
- Manpower ramp up and training take place during the Setup and Startup Periods. During the full rate period a total of 29 FTEs are required to install the NOvA Detector
- An estimated total of **137k** FTE hours are required for the Block Assembly and Installation task
- Full module time and motion studies have not been completed yet, so 100% contingency is used on all labor estimates
- If needed an extra shift would be added to the schedule to keep installation rate on schedule



Manpower Breakdown in TDR

Task assignment	Team 1	Team 2
Crane Operators	2 FTE	2 FTE
Module Technicians	2 FTE	2 FTE
Glue Technician	1 FTE	1 FTE
Block Pivoter Technicians	4 FTE	4 FTE
Outfitting/Scintillator Technicians	2 FTE	2 FTE
Crew Bosses	2 FTE	2 FTE
Administration	2 FTE	1 FTE
Total	15 FTE	12 FTE
Grand Total 29 FTE's		

Full installation rate of 1 block/2.6 weeks



Hiring Plan

Installation stage	# of Blocks	Starting # of FTE's	Ending # of FTE's	Job Class at end of period
60 days – Setup		4*	14	3-Admin, 2 Crane, 2 Crew Boss, 6 Tech
75 days– Startup	3	14	29	3-Admin, 4 Crane, 4 Crew Boss, 18 Tech
437 days – Full rate	33	29	29	3-Admin, 4 Crane, 4 Crew Boss, 18 Tech
50 days – Ramp down	2	29	18	3-Admin, 2 Crane, 2 Crew Boss, 10 Tech
50 days – Install bookend, complete filling	0	18	10	2-Admin, 1 Crane, 2 Crew, 4 Tech,
20 days – Complete outfitting		10	5	2 Admin, 1 Crew, 2 Tech
Total-692 days (138 wks)	38			29 FTE's at Full Rate

* Prior to Setup, 2 Admin, 2 Crew Boss positions filled



Set-up Period~12 weeks

- Set-up period begins right after Beneficial Occupancy-April 2010
- Crew size ramps from 4-14 FTE's
- Critical hiring period, as first workers hired are the last to leave.
- Assume only 50% work efficiency as new employees are trained up and installation procedures are being finalized
- Set-up is devoted to installing and commissioning installation equipment. Expert physicists and engineers from the NOvA design team assist
 - Block Pivoter
 - Adhesive Dispenser
 - South Book End
 - Materials Handling Equipment



Start-up~15 Weeks

- Complete safety tests and readiness review on all installation equipment and procedures
- Expert physicists and engineers assist in training, debugging, and readiness reviews
- Crew size goes from 14 FTE's to full 29 FTE's during first 10 weeks, assume only 50% work efficiency during this training period
- First 3 blocks are built during the start-up period in an average of 5 weeks/block
- As crew size increases switch to 6 days/week 10 hours/day overlapping shift schedule



WBS 2.9.4-Block Assembly & Installation

- 2.9.4.1-Assembly Infrastructure
- 2.9.4.2-Block Assembly Components
- 2.9.4.3-Block Assembly and Alignment
- 2.9.4.4-Detector Plane Filling
- 2.9.4.5-Detector Plane Outfitting
- 2.9.4.6-Detector Commissioning
- 2.9.4.7-Building Outfitting Liaison
- 2.9.4.8-Assembly Crew Management
- * **M & S Costs in this talk are just base costs**



WBS 2.9.4.1-Assembly Infrastructure

WBS #	Title	M&S	Cont.	Labor-FTE
2.9.4.1.1	Work Platforms	\$368k	50%	10 hrs
2.9.4.1.2	Material Handling	\$80k plus WBS 2.9.1.1	50%	235 hrs
2.9.4.1.3	Adhesive Dispenser	\$80k plus WBS 2.9.1.2 & 2.9.2.1.1	100%	160 hrs
2.9.4.1.4	Block Pivoter	\$105k plus WBS 2.9.1.4 & 2.9.2.1.2	100%	480 hrs
2.9.4.1.5	Alignment/Survey	\$15k plus WBS 2.9.1.5	100%	400 FNAL manager & Tech FTE hrs
2.9.4.1		\$648k Base Cost		885 FTE hrs

- Assembly Infrastructure happens during the Set-up period which starts right after Beneficial Occupancy
- Labor costs for WBS 2.9.4.1 are covered under WBS 2.9.4 the hours listed are in those totals



WBS 2.9.4.2-Block Assembly Components

WBS #	Title	M&S	Cont.
2.9.4.2.1	Pallets	\$451k	100%
2.9.4.2.2	Adhesive	\$2,069k	50%
2.9.4.2.3	Overflow Tanks	\$67k	100%
2.9.4.2.4	Module Gap Grout	\$266k	100%
Total-2.9.4.1	Base Cost	\$2,854k	

Labor costs for receiving, moving, and storing these components are covered under WBS 2.9.4

- Largest single assembly component is the ~ 33 gallons per layer of adhesive per layer (10% waste for cleanup)
- Pallets are not only expensive at \$12K each but weight 10,000 lbs and are 53' long x 70" wide x 20" deep
- Approximately 220 gallons of module gap grout is needed for each block to minimize any extra stress on the modules



WBS 2.9.4.3-Block Assembly & Alignment

WBS #	Title	M&S	Labor
2.9.4.3	Block Assembly	\$100k	99,792 FTE hrs

- M&S

- Disposables Items (Adhesive Dispenser nozzles, solvents, PPE, cleaning supplies, etc.)\$100K-100% contingency
- FTE hours listed above include all labor not listed in the other 2.9.4.X tasks



2.9.4.4-Detector Plane Filling

WBS #	Title	M&S	Labor
2.9.4.4	Detector Plane Filling	WBS 2.9.3	10,432 FTE hrs

- Scintillator Fill task does not start until ~ 10 months after Beneficial Occupancy. The startup tasks before Scintillator Commissioning
 - Transfer Facility
 - Distribution Control System
 - Distribution Plumbing
 - Vapor Recovery system (install main vent lines)
- Scintillator Fill Labor
 - Two full time FTE technicians
 - Tasks include testing and monitoring scintillator shipments
 - Filling/topping up modules at the rate of 102,600/block every 2.6 weeks
 - 100% contingency on labor



2.9.4.5-Detector Plane Outfitting

WBS #	Title	M&S	Labor
2.9.4.5	Detector Plane Outfitting	WBS 2.6.7 &2.6.8	10,432 FTE hrs

- Detector outfitting contains 3 major steps during installation
 - Electronics racks and chillers located on the top walkway, which some of that installation can begin before blocks are completed as long as access is not blocked
 - Cable trays, chiller water loops, power and data distribution boxes that are located on the detector blocks. These systems can not be installed until a new two block section is installed.
 - The electronics boxes that hold the sensitive equipment are the last things installed, after modules are filled with scintillator oil to minimize possible damage
 - Some tasks can begin right after Beneficial Occupancy, work on the first 2 block section does not begin till ~ 4 months after BO.
 - Two full time technicians are required for these tasks.
 - 100% contingency on labor



2.9.4.6-Detector Commissioning

- The majority of the Detector Commissioning is done by grad students/post docs from the NOvA collaboration.
- Access to the top of the detector is supplied by the southern most of the two rolling access platforms. Because of the 2 shift schedule it should be available at least 75% of the time
- Outfitting technicians assist as needed, their labor is included as part of WBS 2.9.4.6
- There is no M&S cost associated with this WBS



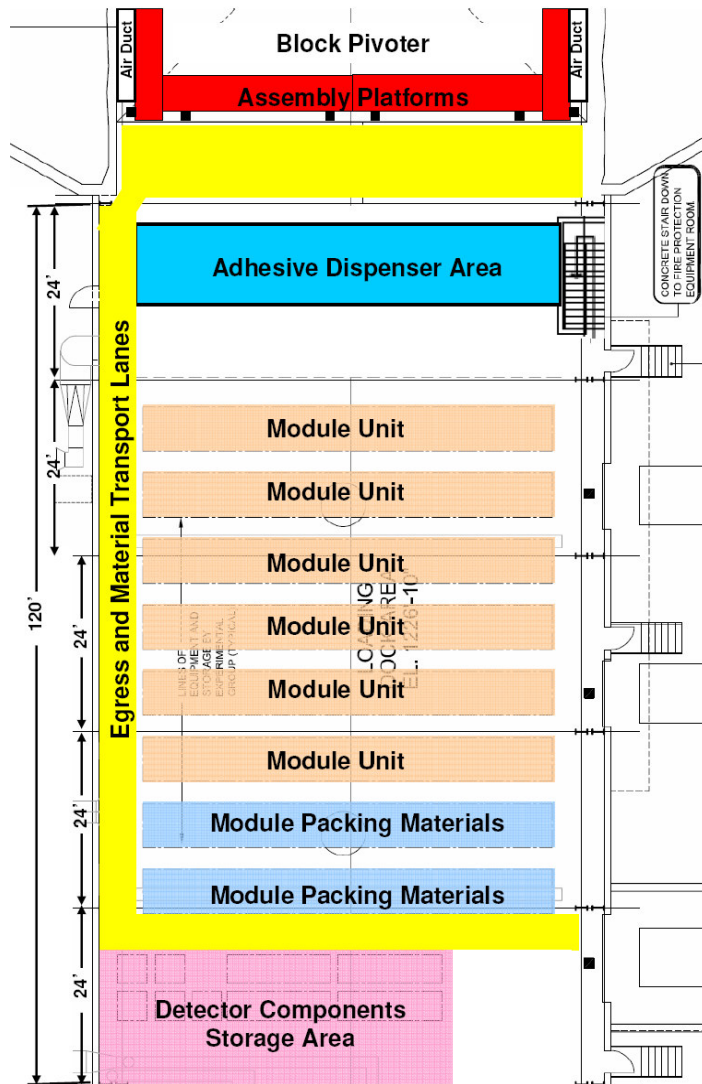
2.9.4.8-Assembly Crew Management

WBS #	Title	Labor
2.9.4.8	Assembly Crew Management	16,048 FTE hrs

- The assembly crew management needs to be hired prior to Beneficial Occupancy by a minimum of 3 months
- Interview and Hiring process is expected to take 2-3 months
- It is critical that first set of new employees are carefully chosen, typically these will be the ones that will become you crew foreman



Materials Storage at Far Detector



- Material shipping is based on a just in time delivery schedule to minimize storage requirements at Far Detector.
- Most detector components are within a day travel or have no immediate impact on the schedule
- Critical component is Module Units (24 modules) ~ 1 per day is needed
- ~ 2 return truck loads of module packing material is shipped back each week
- NOvA Docdb-1433 lists the loading dock requirements



Block Assembly-Module Movement

Minutes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Crane 1	Move module to adhesive dispenser			Move empty crane to North			Pick up empty fixture			Move module to adhesive dispenser			Move empty crane to North			Pick up empty fixture				
Adhesive Dispenser				Unhook crane, glue module, hook-up crane									Unhook crane, glue module, hook-up crane							
Crane 2		Align module on block pivoter		Move Vacuum Fixture back				Move module to block pivoter		Align module on block pivoter		Move Vacuum Fixture back			Move Module					

- 10 minute sequence is based on estimated adhesive dispenser process and speed of cranes.
- Both cranes are moving most of the time
- Crane 1 loads the adhesive dispenser and crane 2 places the glued modules in the block



- ## Week 1

18



Overlapping Schedule

Time	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.	Sun.
6:00							
7:00							
8:00							
9:00							
10:00			Safety				
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							
19:00							

- Each shift is a 10 hour work day, 4 days/week
- During overlap hours, 9 extra “block assembly” workers assist where needed.



Detector Assembly ES&H

- **Develop NOvA Safety Plan:**
 - Form a Safety Committee with Fermilab-ES&H, U of M-ES &H, Far Detector Safety Officer, Far Detector Manager and experts as needed. Use during entire installation and operation phase as issues arise.
 - Safety Committee is used for equipment certification, site inspection as needed, operating procedures
 - Minimum of yearly inspections to insure safe working conditions
- **Hire a FTE U of M NOvA Safety Officer (Operations FTE)**
 - **Should be working during the testing of the block pivoter and full scale block tests at Fermilab to help develop safe working procedures.**
- **ES&H Details-Work in Progress:**
 - Worker training and safety program
 - Material Handling Procedures
 - Lifting fixtures
 - Multiple crane and glue machine movements
 - Adhesive fumes
 - Control, ventilation, monitoring, personnel protection



Detector Assembly ES&H

- **ES&H Details-Work in Progress, Cont:**
 - **Liquid scintillator**
 - HAZWOPER Training-40 hour course/8 hour refresher
 - Procedures for prevention, control, containment and cleanup of spills
 - Personnel protection equipment-Gloves, eyewear, clothing, respirator
 - Removal procedures of liquid from single leaky module
 - Scintillator fume issues-sealed loop filling system
 - **Remote site-35 miles to the hospital in I. Falls, 42 to Cook**
 - First Responder Training-40 hr course/16 hr refresh
 - CPR/AED yearly-4 hours
 - First Aid, High Flow O2, Blood born pathogens yearly-4 hours
 - Emergency drills, rescue drills yearly
 - Fire extinguisher training yearly-3 hours
 - **Weekly full crew safety and information meeting-1 hour**



Summary

- Integration of all WBS tasks supporting the Far Detector is critical to a smooth installation schedule, continue to work closely with supporting WBS tasks
- 100% contingency remains on labor estimates
- R&D program (full plane proto-type, full height block pivoter test, block pivoter test, adhesive dispenser) will help us fine tune the installation process and procedures prior to BO at FD
- Integration of the Building design to installation plans are also critical, building liaison must continue to work closely with design team as the building design goes from 30% to 100%

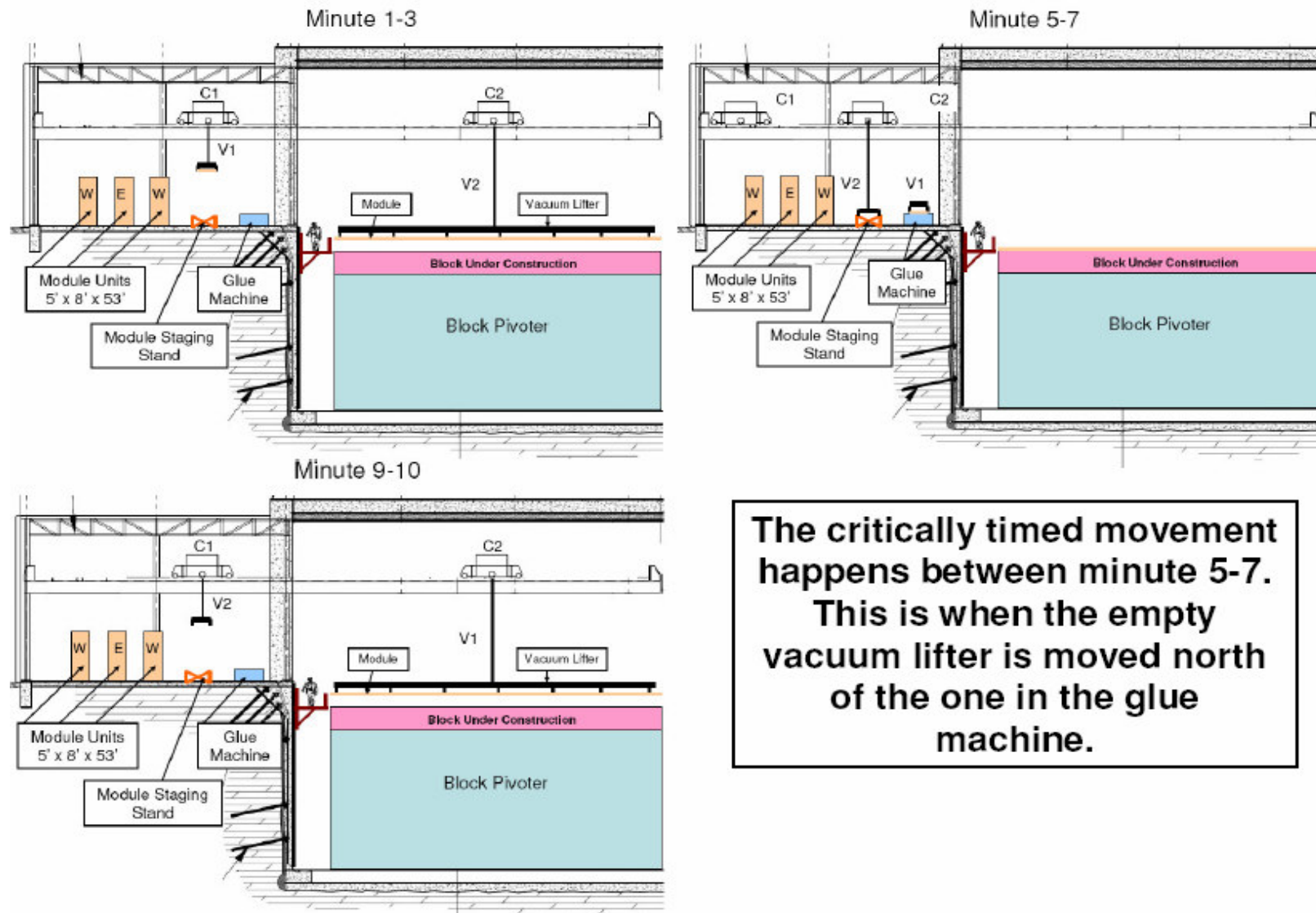


Backup slides

- Detailed time and motion slides



Block Assembly-Module Movement



The critically timed movement happens between minute 5-7. This is when the empty vacuum lifter is moved north of the one in the glue machine.



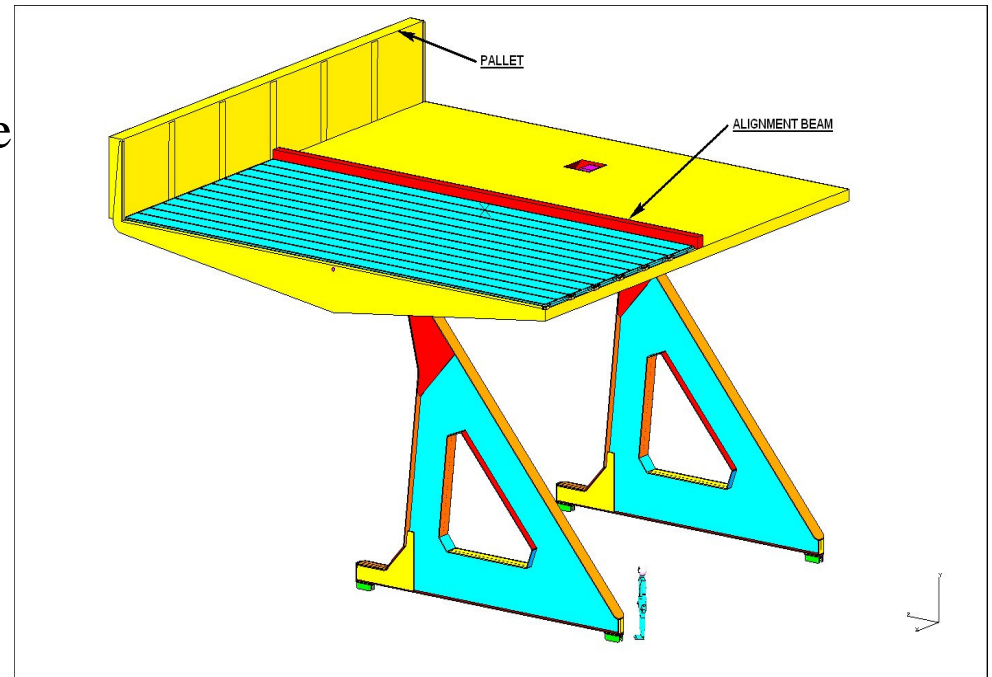
2.9.4.7-Building Outfitting Liaison

- The onsite Lab Manager (William Miller) for NOvA is currently L3 manager for Detector Installation and the Liaison to the building design WBS 2.1
- Labor costs are part of the Cooperative Agreement



Block Assembly-Start an A-Block

- Block Pivoter Preparation
 - Place block pallet magically on grout next existing detector face
 - Allow grout to dry
 - Bolt block pallet to the Block Pivoter
 - Move Block Pivoter back to Assembly Area
 - Add module stops to match block type
 - Vertical planes start with module stop in the middle of the plane
 - Horizontal planes start against a spacer placed against the Block Pallet

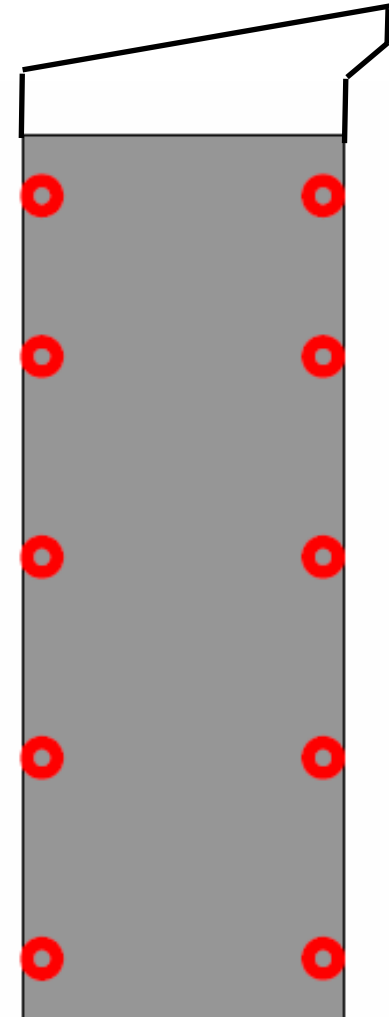


First 6 modules in the first vertical plane



Block Assembly-Planes Tasks

- Survey Procedures
 - Modules are pre-surveyed at the module factories-10 survey points are located
 - After each plane is completed measurements are taken with steel tape measure which is attached to fixed points on the block pivoter. ± 2 mm accuracy is assumed.
- Gap filling procedures-each plane
 - Any gaps between modules or the block pallet must be filled up to 6 m elevation on Vertical modules. A pour-able grout/epoxy is used at the rate of ~ 220 gallons/block
- Next set of module stops depending on Horizontal or Vertical are put in place
- Clean/maintain adhesive dispenser
- Move module units
- **These tasks require ~ 1 hour for the crew of 10 FTE's working on assembly for each plane**





Block Assembly-Block tasks

- **Tight tightening (4 FTEs for 11 hours)**
 - Two coats of paint are required (primer and finish coat). The main area of concern is the top cell on the top horizontal module, the small area of horizontal modules sticking out at each end also need to be painted. Primer must dry ~ 8 hours before second coat. No Vertical modules need to be done
- Remove module alignment stops and any other fixtures
- Add any support brackets as required
- Secure block for movement
- **Block Pivoter moving sequence (~8 hours)**
 - Move Pivoter to block face, Rotate, place in final position
 - If block does not uniformly press against existing detector face, re-lift and shim under pallet as needed
 - Move block pivoter back to assembly area
- Block Safety Restraint Beam is moved in place
- Final Block survey is done



Backup slides

	Set up	Start up	Full Rate	Ramp Down	Comp Filling	Comp Outfit	Total Days	Total Hours	Burdened Wage
# of Days	60	75	437	50	50	20	692	Days*8 hrs	
Equipment Operator	2	4	4	2	1	0	2318	18544	\$591,182.72
Principal Lab Tech	5	14	14	6	0	0	7768	62144	\$1,505,749.12
Scintillator/Out Tech	2	4	4	4	4	2	2608	20864	\$505,534.72
Research Forman	2	4	4	2	2	1	2388	19104	\$798,738.24
Executive Assistant	2	2	2	2	1	1	1314	10512	\$721,018.08
Office Assistant	1	1	1	1	1	1	692	5536	\$126,442.24
	14	29	29	17	9	5		136704	
								Total Wages	\$4,248,665.12

Block Assembly

\$2,895,670.08



Backup Slides

WBS Task	Name	Responsibility	Time Period	Crew Boss			Operator			Technician			Total Hours	Total Cost
				Hours	Wage	Cost	Hours	Wage	Cost	Hours	Wage	Cost		
2.9.1	Mechanical Systems													
2.9.1.1	Module Lifting Fixtures	J. Grudzinski	Set-up	40	\$41.81	\$1,672		\$31.88	\$0	200	\$24.23	\$4,846		
2.9.1.2	Adhesive Dispenser	J. Grudzinski	Set-up	40	\$41.81	\$1,672		\$31.88	\$0	120	\$24.23	\$2,908		
2.9.1.3	Block Safety Beam	Vic Guarlo	Set-up		\$41.81	\$0		\$31.88	\$0		\$24.23	\$0		
2.9.1.4	Block Pivoter	D. Pushka	Set-up	80	\$41.81	\$3,345	80	\$31.88	\$2,550	320	\$24.23	\$7,754		
2.9.1.5	Survey Equipment	P Lukens	Set-up	60	\$41.81	\$2,509		\$31.88	\$0	240	\$24.23	\$5,815		
2.9.2	Detector Infrastructure													
2.9.2.1	Electrical Infrastructure	W. Miller	Set-up		\$41.81	\$0		\$31.88	\$0		\$24.23	\$0		
2.9.2.2	Machine Shop	W. Miller	Set-up	20	\$41.81	\$836		\$31.88	\$0	160	\$24.23	\$3,877		
2.9.2.3	Bookends	Vic Guarlo	Set-up		\$41.81	\$0		\$31.88	\$0		\$24.23	\$0		
2.9.2.4	Shield Wall	Vic Guarlo	Set-up		\$41.81	\$0		\$31.88	\$0		\$24.23	\$0		
2.9.2.5	Control Room	W. Miller	Set-up	10	\$41.81	\$418		\$31.88	\$0	40	\$24.23	\$969		
2.9.2.6	Office Area	W. Miller	Set-up	20	\$41.81	\$836		\$31.88	\$0	80	\$24.23	\$1,938		
2.9.2.7	Safety Equipment	W. Miller	Set-up	20	\$41.81	\$836		\$31.88	\$0	160	\$24.23	\$3,877		
	Safety Training	W. Miller	New Employees	96	\$41.81	\$4,014	96	\$31.88	\$3,060	96	\$24.23	\$2,326		
	Safety Training	W. Miller	Yearly Refresher	40	\$41.81	\$1,672	40	\$31.88	\$1,275	40	\$24.23	\$969		
			Total Setup Period	386			176			1416				
			Total Setup available	~800			~800			~2000				
2.9.3	Scintillator Filling													
2.9.3.1	Scintillator Transfer Facility	J. Musser	Setup/Startup											
2.9.3.2	Scintillator Distribution Plumbing	J. Musser	Setup/Startup											
2.9.3.3	Scintillator Fill Machines	J. Musser	Setup/Startup											
2.9.3.4	Vapor Recovery Systems	J. Musser	Startup/Full Rate											
2.9.3.5	Commission	J. Musser	Setup/Startup											
2.9.4	Block Assembly													
2.9.4.1	Assembly Infrastructure	W. Miller	Setup/Startup											
2.9.4.2	Block Assembly Components	Many	All											
2.9.4.3	Block Assembly	W. Miller	Startup/Full Rate											
2.9.4.4	Detector Plane Filling	J. Musser	Full Rate											
2.9.4.5	Detector Plane Outfitting	WBS2.9.?	Startup/Full Rate											
2.9.4.7	Building Outfitting Liason													
2.9.4.8	Assembly Crew Management	W. Miller	All											